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ABSTRACT

The National Environmental Education and Training Foundation (NEETF) commissioned the North American Association for Environmental Education (NAAEE) to prepare this report in order to provide the education community and the American public with information about successful environment-based education programs in the nation's schools. The report consists of a collection of case studies of schools in Texas, North Carolina, Wisconsin, Minnesota, Kentucky, and Florida that are using the environment to motivate students to learn and bring new life and meaning into their school experience. These studies document current evidence supporting the premise that, compared to traditional educational approaches, environment-based education provides academic performance across the curriculum. (SAH)

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Environment-based **Education**

Creating High Performance Schools and Students

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FOREWORD

To provide the education community and the American public with information about successful environment-based education programs in the nation's schools, the National Environmental Education & Training Foundation (NEETF) commissioned the North American Association for Environmental Education (NAAEE) to prepare this report, written by Joanne Lozar Glenn.

This report follows the seminal report, *Closing the Achievement Gap: Using the Environment as an Integrating Context for Education*, by Gerald Lieberman and Linda Hoody, published in 1998 by the State Environmental Education Roundtable. Dr. Lieberman detailed the remarkable successes of 40 schools in 12 states that use comprehensive environment-based programs to motivate student interest and improve academic achievement.

This report consists of a collection of case studies of schools in Texas, North Carolina, Wisconsin, Minnesota, Kentucky, and Florida that are using the environment to motivate students to learn, and bring new life and meaning into their school experience. These studies document current evidence supporting the premise that, compared to traditional educational approaches, environmental-based education improves academic performance across the curriculum.

We would like to express our sincere appreciation to the many people – teachers, students, administrators, and educational researchers – who contributed their ideas and experiences to this report, particularly to Edward McCrea, former executive director of NAAEE. The case studies come to life because of their personal observations about the potential of environment-based education to inspire and instruct. In particular, we wish to thank Libby Rhoden, Kruse Elementary School, Pasadena, Texas; Vicki Deneen, Isaac Dickson Elementary School, Asheville, North Carolina; Robert Helminiak, Hawley Environmental Elementary School, Milwaukee, Wisconsin; Tom Goodwin, The School of Environmental Studies at the Minnesota Zoo, Apple Valley, Minnesota; Jane Eller, the Kentucky Environmental Education Council, Frankfort, Kentucky; Cecelia Stevens, Tompkinsville Elementary School, Tompkinsville, Kentucky; Susan Toth, Pine Jog Environmental Education Center, West Palm Beach, Florida; Connie Gregory, the Palm Beach City School District; Carol Basile, educational researcher; and Martha Fields, Condit Elementary School, Bellaire, Texas.

In addition, our special thanks go to the students quoted in this report who shared with us their insights into how their environmental-based education has given them new faith in their own abilities and new hope for their futures.

We are deeply grateful to the AT&T Foundation for their generous support that made this report possible.

Marcia P. Sward, Ph.D.
Senior Director, Education & Environment Program
National Environmental Education & Training Foundation

EXECUTIVE SUMMARY

Since 1983, with the release of *A Nation at Risk*, Americans have been engaged in a journey toward creating more effective schools. Educational statistics show that there is still much progress to be made on the way to becoming a competent and literate society. The school reform movement is calling for well-educated individuals who have a deep and abiding knowledge of the world in which they live. Society is asking for citizens who are prepared to take active roles in their communities. Business is calling for "renaissance workers," workers skilled in the leadership competencies that will be required in the increasingly complex global environment.

"[EE] is an ideal thematic approach to integrating subject areas, and it's motivating. It's so good for kids who don't do well in traditional classes. EE takes kids who thought they wouldn't even finish high school and raises their sights."

— Jane Eller, Kentucky Environmental Education Council

Environment-based education is a maturing discipline well suited to achieving these goals. It is a natural way to integrate the curriculum around issues of interest to students and teachers. The experiences of the schools documented in this report suggest that environment-based education holds great promise for furthering school reform goals, creating active and engaged students, and preparing citizens to live and work in the 21st century.

In this report are case studies of five individual schools, a model school program involving five schools, and a statewide program, all of which have adopted EE as the central focus of their academic programs. Also included is a case study of a school that participated in an educational research project on the use of environment-based education in teaching transfer of knowledge. The results in all of the schools studied are impressive and heartening, as the nation searches for effective ways to improve the quality of education our children receive in public and private schools:

- **Reading scores improve, sometimes spectacularly.** A notable example is the performance of Third-Grade students at Hawley Environmental Elementary School in Milwaukee, Wisconsin. All of these students passed the Wisconsin Reading Comprehension Test, as compared with only 25% of the total Milwaukee public school population.

"Environmental education does cut down discipline problems. Kids relate well to studying the world around them and they want to learn reading and math."

— Estelle Vollmers, Hawley Elementary School, Milwaukee, Wisconsin

- **Math scores also improve.** Typically, in environment-based programs, students' scores on standardized math tests improve. At Isaac Dickson Elementary School in Asheville, North Carolina, Grade Four students achieved a remarkable 31 percentage point increase in math achievement in just one year.
- **Students perform better in science and social studies.** On state and national social studies and science tests, the scores of students who engaged in environment-based studies almost always exceeded those of students in traditional programs. At the School for Environmental Studies in Apple Valley, Minnesota, for example, students who took the ACT test for college admission scored higher than their peers in the district, the state, and the nation.

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- **Students develop the ability to make connections and transfer their knowledge from familiar to unfamiliar contexts.** At Condit Elementary School in Bellaire, Texas, Third-Grade students who took part in the research-based environment program successfully solved problems involving natural habitats and sharpened their higher-level thinking skills. These results were confirmed by researcher Carol Basile via several test instruments designed for this purpose.

"Kids make connections across disciplines. We believe this not only brings [learning] alive, but also reflects real life and allows students to do the kind of thinking that problem solving in the real world requires."

— Dan Bodette, Principal, School of Environmental Studies, Apple Valley, Minnesota.

- **Students learn to "do science" rather than just "learn about science."** Using nature as an outdoor laboratory helps create conditions conducive to learning. Students' natural interest in the environment motivates them to learn and understand the complexities of their world. Increased student motivation was observed in all of the schools and classrooms included in this study.
- **Classroom discipline problems decline.** Teachers who use environment-based strategies often note that classroom discipline problems decline, and formerly disruptive students "find themselves" in the environment's hands-on approach to learning. Improved classroom behavior was observed by virtually all of the teachers in the schools studied.
- **Every child has the opportunity to learn at a high level.** Teacher after teacher in Kentucky reported that students previously performing at low academic levels "came alive" when introduced to an environment-based curriculum. As Jane Eller, Kentucky Environmental Education Council, puts it: "The main tenet of our educational system is that every child can learn at a high level. In just a few years, we've begun to see schools from some of our poorest neighborhoods do very well on the assessment. We think this proves what we believe in Kentucky... that there is a way to reach every child."

THE ENVIRONMENT AS AN INTEGRATING CONTEXT FOR LEARNING

These results are consistent with the findings of the study *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning*, by Dr. Gerald Lieberman and Linda Hoody, State Education and Environment Roundtable (SEER), 1998. Indeed, it was this study that inspired the preparation of this set of case studies. SEER has recently completed additional studies at schools in Florida and California. These studies triple the number of schools for which there is reliable test data, and further confirm the various benefits, both academic and behavioral, of environmental learning. Overall, 60 schools that have adopted environment-based education have been studied.

"Using the Environment as an Integrating Context for learning (EIC) defines a framework for education: a framework for interdisciplinary, collaborative, student-centered, hands-on, and engaged learning. It has begun to transform curricula in a growing number of schools across the United States and may have the potential to significantly improve K-12 education in America....

"The observed benefits of EIC programs are both broad-ranging and encouraging. They include:

- better performance on standardized measures of academic achievement in reading, writing, math, science, and social studies;
- reduced discipline and classroom management problems;

Closing the Achievement Gap, Executive Summary, Gerald Lieberman and Linda Hoody, State Education and Environment Roundtable, 1998.

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- increased engagement and enthusiasm for learning; and,
- greater pride and ownership in accomplishments."

In 1999, the Education Commission of the States (ECS) recognized SEER's EIC program as a "promising practice...that show(s) evidence of success in improving student achievement. ECS recognizes EIC as a promising practice for both comprehensive school reform and improving education for at-risk students." This is a crucial statement of recognition as many states require troubled schools to select their reform models from ECS's "promising practices" database. ■

MAINSTREAMING ENVIRONMENT-BASED EDUCATION

The use of the environment — from the classroom environment, to the schoolyard, to local nature centers and parks — has been discovered by schools across the nation as a remarkably effective means to achieve our educational goals and to serve the needs of individual students. However, many teachers, administrators, school board members, and others responsible for the school curriculum are still unaware of the power of this approach. Much can be done to bring this critical new information to the education community and to the public. Much can also be done through educational research to deepen understanding of the power and potential of environment-based education.

Over the last 10 years the U.S. Environmental Protection Agency (EPA), authorized by the National Environmental Education Act, has taken a lead in educating the public about threats to our environment and actions that can be taken to protect it. EPA has also supported the field of environmental education in schools and colleges and through programs of non-formal education. The EPA has worked with educators and administrators at national, state, and local levels to expand its reach into mainstream issues, such as education reform. Other U.S. government agencies, in particular the U.S. Department of Education and the National Science Foundation, should now join the EPA in assuming responsibility for identifying, promoting, and supporting new programs, educational research, and public information about environment-based programs.

We recommend that:

- The U.S. Department of Education establish an Office of "Ombudsman for the Environment." The function of the office would be to establish close linkages and coordination with the relevant units of the Department of Education, and with the EPA, the National Science Foundation, and other government agencies concerned with U.S. education.

  The Ombudsman should be advised by a broad-based Policy Steering Group, which would meet regularly to discuss specific opportunities for policy reform and action items such as key proposals, contacts, meetings, etc. This group could help to define an effective role for environmental learning in education reform efforts. The group would include leading environmental education organizations and also important education leaders such as science and social studies teacher organizations, school administrators and others who can open doors in the education area. Duties could also include

  - The compilation of needed research and case support. In addition to this report and the SEER report, there are numerous other research efforts in education and social sciences that must be assembled and packaged for opinion leaders.
  - Support for further research on the efficacy of environmental education, including use as an integrating context for learning, and how environment-based learning develops reading skills, science and social study facility, and more.
  - Promotion of the National Project for Excellence in Environmental Education's guidelines for materials, learning and educators as a means of supporting education reform goals.

- The development of environmental-based school-to-work programs that test and demonstrate how the environment can be a useful tool for developing in students the skills they will need to succeed in the future workplace.
- Examination of the effectiveness of education about the environment in supporting education standards such as those for science, mathematics, social studies, and geography.

- Conduct community-and-the-environment demonstrations to test and demonstrate how community outreach programs by schools and students can be enhanced and how communities can get more involved in the schools using the environment as a tool. These would include such initiatives as service-learning programs, after-school programs, and community crime reduction efforts.
- Build on existing cooperative ventures with public land managers (such as the U.S. Bureau of Land Management, the U.S. Forest Service, and the National Park Service), corporate land holders, and others with lands of outstanding educational value to demonstrate their usefulness as educational resources for experiential learning. Parks, marine sanctuaries, nature centers, and many others already have good and potentially effective programs in place. They need to be better supported so they can reach their potential as integral components of K-12 education. In addition, new lands need to be identified and secured for educational uses, and liaisons with near-by schools created.

These activities should be carried out in cooperation with the National Academies of Science and Engineering, State Departments of Education, and with key educational, mathematical, scientific, social science and environmental organizations. ■

Students Learn Through Real-World Problem Solving

Jeremy, a high school senior, often admitted that he had trouble "tying facts together." In addition, his writing skills were weak. After Jeremy got involved in the environmental program at his school things changed. The program required that he write a 2400-word paper, complete an action project, and present his conclusions to a community panel. Not only was his paper "awesome," according to his English teacher, but Jeremy went further. On his own initiative submitted an editorial based on his research to his state capital's newspaper, and it was published.

Jeremy's teacher writes:

I believe the relevance of the eco-ed, along with the fact that he is seeing that curricula spread from class to class, was the difference. Do you know that over 15 students have asked me to be their mentor for the senior projects? All environmental projects.

Annie is a Third-Grade student in a Florida inner-city school that incorporates an environmental focus into school activities and curriculum. Like many people raised in urban environments, she had learned to fear snakes. But Annie's class was studying interdependence, or as she called it, "teamwork," in the natural world, and Annie chose to study snakes. When a school visitor later asked her about her work, Annie didn't hesitate. "My project is on snakes," she said. "They're beautiful." And then she told the visitor all about how snakes team up with nature and why they belong in the world.

Michael, a shy boy, is doing a project on brown algae. According to his mother, Michael previously never took an interest in the environment. But last month, on his own, Michael replied to a newspaper editorial citing the errors the author had made about toxic substances.

Michael's teacher writes:

I believe he felt comfortable with the marine science class he took and saw that it had real-world application. I have said for years that eco-science is the glue that can tie many subjects together. I call it the "by the way" technique. You are talking about biodiversity in Ethiopia, and you say, by the way, what countries surround Ethiopia? What direction does the Nile flow? What sea does it dump into? The kids don't get it as "Name three of these..." or "Do this worksheet." They see it as the nuts and bolts of the discussion. I have countless [more] examples...with the paperwork as the proof.

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MAKING THE CASE FOR ENVIRONMENT-BASED EDUCATION

THE CALL TO IMPROVE ACADEMIC ACHIEVEMENT

The title of the 1983 report, *A Nation at Risk*, said it all. America was struggling to regain "its once-unchallenged pre-eminence in commerce, industry, and science innovation." America's educational foundation was being eroded, the writers said; we were essentially committing "an act of unthinking, unilateral educational disarmament." With those words, the National Commission on Excellence in Education launched the educational reform movement that is driving school change today.

Annie, Jeremy, and Michael (see page 10) are students in schools that have changed. Because their schools use the environment as an integrating context for learning, they have experienced the active study and real-world problem-solving instructional strategies that characterize the school reform movement.

But other American students may not be as fortunate. In spite of progress in the elementary schools, students in high schools still lag behind the benchmarks set in the Goals 2000 legislation, passed by Congress in 1994. The 1999 follow-up report, *A Nation Still at Risk*, states that student achievement remains flat and college remediation rates have risen to unprecedented levels.

Not only is the educational community calling for more stringent academic standards and higher achievement, but so is American business. Business leaders say they need better-educated, "renaissance" workers. In its 1999 Yearbook, *The 21st Century: Meeting the Challenges to Business Education*, the National Business Education Association profiled the kinds of employees industry wants: employees who can work in teams, create analytical reports, interpret data, and make decisions; leaders and visionaries; critical thinkers; skilled communicators; self-starters who are flexible and ethical.

THE NATIONAL CHALLENGE: GOALS 2000

Serious educational reform targets the changes in thinking and learning that can help students become the kind of workers and citizens that America wants and needs to address today's and tomorrow's challenges. The Goals 2000 movement for school reform articulates these challenges through the following eight goals:

- Create a student population that is ready to learn (Goal 1) and will complete all four years of high school (Goal 2).
- Rigorous, measurable benchmarks for student achievement and active citizenship (Goal 3);
- Properly prepared and trained teachers (Goal 4);
- Being first in the world in math and science (Goal 5);
- Developing in students the traits that will lead them to become literate adults and lifelong learners (Goal 6);
- Safe, disciplined, drug-free schools (Goal 7);
- More parental participation in the schools (Goal 8).

These are all worthy goals, and much progress has been made toward them since the original Goals 2000 legislation was passed. However, full achievement of the goals remains one of the nation's greatest challenges. To meet the challenge requires a deep understanding of the conditions under which students learn. Current studies clearly support the idea that students make significant gains in skills and cognitive development when they

- are motivated;
- exercise choice about what they learn and how they learn it;
- have teachers who are excited about what they're teaching, and have had a hand in designing the curriculum;
- work collaboratively with other students, teachers, and the community; and,
- begin to make connections across disciplines.

The following characteristics are hallmarks of environment-based education:

- integrated learning across disciplines,
- problem solving,
- decision making,
- independent and group learning,
- issues-based instructional activities, and
- a balanced variety of perspectives.

These are precisely the strategies that are linked positively to academic achievement. And what's more, teachers and administrators consistently report that students like learning about the environment, which motivates them to learn other subjects because they can see that they need the information and techniques in other subject areas as tools for exploring their environmental interests.

In addition, environmental learning emphasizes specific skills central to "good science," which creates a rigorous curriculum and develops critical thinking skills needed for informed personal decisions and public action. Students base learning on prior knowledge, and what they learn is related to clearly stated outcomes, like those described in the North American Association for Environmental Education (NAAEE) document, *Excellence in Environmental Education: Guidelines for Learning (K–12).*

Environment-based education holds promise for furthering school reform, creating active and engaged citizens, and raising academic achievement in all subjects, not just in environmental science. In environment-based programs, students practice the skills important to creating the renaissance worker sought by American business: one capable of self-direction, systematic and critical thinking, competent interpretation of data, well-reasoned decision making, skilled communication, flexibility in work style, and ethical behavior. Environment-based learning facilitates the development of citizens who understand the complexities of the relationship between resources and the economy. Simply stated, environment-based education prepares students to live in the world.

FACTORS INFLUENCING ACHIEVEMENT

Various factors have been found to influence achievement. Such factors as motivation, school structure, and curriculum, may at first appear immutable, but on closer examination, can be influenced by how teachers and administrators choose to achieve academic goals. (See Table 1.)

For example, a recent article in *Educational Leadership* profiled Baltimore-based Patterson High School, which created small schools, or academies, within the larger building. As a result, teachers and administrators discovered that the personalized atmosphere created a climate more conducive to learning. In addition, refocusing the curriculum to be more thematic and including opportunities for students to influence their own learning deepened student motivation, which in turn decreased discipline problems and increased achievement. The authors noted that when students become members of a smaller learning community focused on a course of study that the students themselves select because it matches their interests and career goals, they behave better, and treat their teachers and the school building itself with more respect.

THE VALUE OF INTEGRATED LEARNING

"Integrated learning," that is, learning that is inter-disciplinary and problem-based, appears to be a significant factor in increasing academic achievement. For example, data in the 1997 report *Science Achievement in Minnesota in the Middle School Years — Results from IEA's Third International Mathematics and Science Study (TIMMS)* by Kristin Voelkl and John Mazzeo provides some evidence that students, such as those in Minnesota, who participate in integrated science programs fare better academically than those in non-integrated programs. At the Seventh- and Eighth-Grade levels, these Minnesota students scored above average for all 41 nations studied. Only Singapore scored significantly higher (and Singapore uses an integrated science approach). No other countries scored higher in percentage of answers correct on Earth Science and Life Science than Minnesota, and only Singapore scored higher in the Environmental Issues and the Nature of Science. In both grades, four out of the five top-scoring countries in overall science achievement taught science through integrated programs.

USING THE ENVIRONMENT TO INTEGRATE THE CURRICULUM

In 1998, the State Education and Environment Roundtable (SEER) — a cooperative endeavor of 12 state education agencies — released findings on the impact of the environment as a tool of greater academic achievement. In *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning*, the remarkable academic and behavioral results at 40 schools in 12 states are described. Although the programs differ in many ways, all used the environment as an "integrating context"— for science, math, social studies and language arts. Not only were there significant improvements in academic achievement, but enthusiasm and the desire to both learn and to teach increased in each of the studied schools.

Certain subjects — the arts, geography, archeology, and others — are being used by some schools as subject "integrators" that help students see a context of learning in the real world. They show that, as in life, learning is not easily divided into separate boxes and acquired in isolation. The SEER study makes an intriguing and important case for the environment being one of the most useful integrators available today. The environment as a subject is naturally inter-disciplinary, place-based, and lends itself to inquiry-based learning and team teaching. Environmental learning helps students make the connections they need to transfer concepts from familiar to unfamiliar contexts. Its interdisciplinary nature helps students to understand the world around them and sharpens their ability to think systemically. The content and skills taught can be correlated to national and state standards and can provide an effective, interesting and motivating way to tie the curriculum together.

"I've learned a lot more than I ever did at my old school. There, they spoon fed you. Here, they leave [learning] up to you, and that makes it easier to learn, and to want to learn more."

— Student

A GOOD TIME TO MAINSTREAM ENVIRONMENT-BASED EDUCATION IN THE NATION'S SCHOOLS

America's parents give environmental learning in the schools a 96% approval rating (The 1999 National Environmental Education & Training Foundation and Roper Starch Worldwide Survey). This level of parental support makes environmental education even more attractive, since it sets the stage for increasing the level and degree of parental involvement with their children and with their children's schools.

Combined with the convergence of other educational trends, this remarkable level of parental approval makes this a propitious time to bring environment-based learning into the mainstream of K-12 education. Indeed, there has never been a time when there was more solid research combined with recent policy changes and leadership opportunities. ■

TABLE 1. SUMMARY OF FACTORS THAT INFLUENCE ACHIEVEMENT

	POSITIVELY	NEGATIVELY
External	• Male gender • Member of Caucasian race; Asian immigrant • Average or above-average income • High expectations of teachers and parents Sources: National Science Foundation (1996); Lieberman (1998); Phillips (1997)	• Female gender • Member of minority race • Under- or un-educated parents • Poverty • Tracking/ability grouping Sources: National Science Foundation (1996); Lieberman (1998)
Internal	• Motivation Source: Abbott (1999)	• Motivation (lack) Source: Abbott (1999)
Social	• Ability to connect with teacher and fellow students (smaller learning communities) Source: McPartland et al. (1997)	• Poor or remote relationship with teacher (larger or "anonymous" learning communities) Source: McPartland et al. (1997)
Curricular	• Matching teaching style to learning style • Engaging material; engaged teachers and learners • Student choice in curriculum • Collaborative learning • Participation in group discussion at school and home • Demanding subject matter • Problem-based learning • Issues-based, real-world instructional activities • Teaching for connections • Using environment as an integrating context Sources: Klein (1995); Klavas (1994); McPartland et al. (1997); Leinhardt (1998); Yamzon (1999); Basile (in press); New American Schools (1999); Marks (1997); Lieberman (1998); Krynock and Robb (1999)	• Using same teaching style for all students • Unengaged teachers • Teacher-centered instruction • Irrelevant curriculum • Traditional teaching methods such as lecture • Subject matter that is too easy Sources: Klavas (1994); Leinhardt (1998); Marks (1997); Lieberman (1998); Krynock and Robb (1999)
Administrative	• Common vision • Implementation of comprehensive reform programs • Teacher empowerment • Access to assistance, in-service training, and resources Sources: New American Schools (1999); Marks (1997)	• Lack of focus • Lack of administrative support or attention to enhancing teacher quality/competence Sources: New American Schools (1999); Marks (1997)

A "Teachable" Moment

Four saltwater crabs, each as small as a thumbnail, and one larger crab lived in teacher Libby Rhoden's aquarium at Kruse Elementary School in Pasadena, Texas. Yet one morning, the students noticed that the five crabs had turned into seven overnight. "They just knew that the big crab had babies," Rhoden says. Then she laughs.

Over the next few days, the students realized that two of the crabs were growing larger, and that they appeared to be eating their babies. Upon closer observation, the children figured out that the crabs had not had babies after all: they simply had lost their shells, on which they were now feeding, and Rhoden had a "teachable moment."

The students' knowledge of this and other environmental concepts comes as a result of Rhoden's inquiry-based teaching and the students' own curiosity. They've conducted experiments to observe how crabs react to different foods, smells, fresh versus salt water, and fluctuating temperatures. Fascinated by what they were discovering, they then progressed from studying crabs to studying larger ecosystems of marine life.

CASE STUDY #1:

Kruse Elementary School, Pasadena, Texas

Kruse Elementary School is an urban school in Pasadena, Texas. All of its 800–900 students, mostly Hispanic, live in an area five miles square near a refinery. The school receives Title I funding and approximately 87% of its students receive free or reduced-price lunches.

"Older gifted and talented kids are amazed at the inquiries my First Graders are doing. They cannot believe their level of understanding."

Libby Rhoden, Teacher

Libby Rhoden teaches a class of 19 children, one of eight First Grade classes at Kruse. Because her students' achievement test scores are high, she gets a lot of leeway with the curriculum. Rhoden bases her lessons on experiences the children have. For example, she might use what students notice on a nature walk, have them write about their observations, and then use that material as reading instruction during the next few days. She integrates phonics by including high-frequency words and introducing other words related to the students' experience—such as nest building, feeding, and flying. Then she incorporates mathematics by having the children tally how many birds were doing each activity, and together they chart the results.

Academic Outcomes at Kruse

Rhoden's Students Consistently Outperform Other First Graders

Rhoden's students have consistently performed better than the rest of Kruse Elementary's First Graders in in reading, language, and math, *even though the children are not ability grouped*. Tables 2 and 3 compare scores from Rhoden's 1995 class with the average scores achieved by the entire First Grade class on the Iowa Test of Basic Skills. The children were not tested in science or social science, so no comparisons could be made in these areas.

"If a teacher has a lesson on metamorphosis planned using butterflies, but a bird building a nest is observed, go with the nest-building. The concept can be taught through either experience. Learning is more effective when the child has an experience to which he can relate."

— Libby Rhoden, Teacher

Comparisons between Rhoden's class and the entire school building demonstrate that more often than not, Rhoden's class exceeded building averages. Comparisons between Rhoden's class and national averages demonstrate that Rhoden's students frequently scored the same as or higher than national norms. In fact, in 1998, their scores exceeded national averages in the categories reported in Table 4.

Summary of Experience with Environmental Education at Kruse

Students in Environment-Based Program Achieve at Significantly Higher Levels

The test results support the assertion that Rhoden's approach positively influenced her students' achievement in reading, language, and mathematics, especially considering that the students in Kruse

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Elementary are not ability grouped, and that Rhoden's classes consistently out-perform the other First Grades. Rhoden's students develop understandings and concepts that are more advanced than what might be expected for their age.

Perhaps because reading and math are used as tools rather than as ends in themselves, and perhaps because reading and math are learned in a real-world context, students are more competent in these skills compared to other students taught in more traditional ways. Without a control group, however, it is difficult to clearly distinguish between the influence of the curriculum and the influence of the teacher. ■

TABLE 2. IOWA TEST OF BASIC SKILLS* REPORT OF CLASS AVERAGES** KRUSE ELEMENTARY SCHOOL, FIRST GRADES

	Reading			Language			Mathematics		
	Vocabulary	Comprehension Advanced Skills	Total	Listening	Language Advanced Skills	Total	Concepts	Problems Advanced Skills	Total
Rhoden: Spring 1995	2.0	1.9	2.0	1.5	1.7	1.5	1.7	1.5	1.7
Entire First Grade: Spring 1995	1.2	1.6	1.5	1.2	1.2	1.1	1.4	1.2	1.5

*Scores are reported as grade equivalents. E.g., 1.6 is equivalent to grade one, month 6.
**Students were not tested in social studies or science.

TABLE 3. IOWA TEST OF BASIC SKILLS* REPORT OF CLASS AVERAGES, CONT'D.** KRUSE ELEMENTARY SCHOOL, FIRST GRADES

	Core Total	Word Analysis	Computation
Rhoden: Spring 1995	1.7	1.6	1.9
Entire First Grade: Spring 1995	1.3	1.3	1.6

*Scores are reported as grade equivalents. E.g., 1.6 is equivalent to grade one, month 6.
**Students were not tested in social studies or science.

TABLE 4. IOWA TEST OF BASIC SKILLS GROUP ITEM ANALYSIS COMPARISONS: KRUSE ELEMENTARY SCHOOL AND NATIONAL AVERAGES (%)*

	Spring 1997								
	Reading			Language			Mathematics		
	Vocabulary	Comprehension: Facts	Comprehension: Inference	Literal Meaning	Developmental (Oral)	Listening: Predict Outcome	Geometry	Problem Solving	Computation
Rhoden	55	62	51	45	57	66	84	50	77
Entire building	38	44	39	40	49	63	78	49	71
National	50	58	51	44	59	73	80	59	74
	Spring 1998								
Rhoden	63	66	57	71	91	85	82	64	75
Entire building	48	62	53	50	66	66	83	55	67
National	50	60	53	44	59	73	80	59	74

*Scores reflect percentage of items answered correctly.

Three Environmental Projects at Dickson

GARDENING/SCIENCE CLUB

One afternoon each week, a garden coordinator, funded through Learn and Serve America, meets with students to teach them a specific environmental concept. For example, students might read an article about life cycles and how materials can be recycled into the earth. They might then collect recyclable materials that other classrooms have saved, and add a layer of food material to mini-compost bins that will "feed" the garden. Each project also incorporates reflective time, in which students either write or discuss the services they've provided to the school and the community.

MAGIC PROGRAM

In this program, a trained garden educator works with three Dickson classes, for a period of two hours and 15 minutes per class, each week. The students learn about nutrition by, growing and then studying food products from the school garden. They might create nutritious meals for the school or share some of their produce with a social service organization, such as The Mission on Patton Ave.

In each case, the experience begins with an academic component, progresses to hands-on activities, then concludes with reflection and assessment. Assessment may take the form of a writing prompt, original scripts and drama productions, or "tests" that resemble reading passages from the North Carolina End-of-Grade Assessment.

RE-ESTABLISHING THE NATURE TRAIL

Under the direction of Dickson's assistant principal, the U.S. Forest Service, Quality Forward, the Department of Natural Resources, and MAGIC collaborated to re-establish a previously abandoned nature trail at the rear of the school property. During the 1998–99 school year, adult volunteers donated 500 hours of bulldozing, digging, cutting tree branches, and mulching so that individual classes and their teachers could plan and construct habitat study sites.

Curriculum resources and trail guides were developed. The guides include activities that highlight diversity and different learning styles, engaging students and making them aware of environmental issues. Because the school has been designated a WILD Education Site by the North Carolina Wildlife Commission, it receives additional staff training as sites are further developed by teachers and their students. In keeping with the service learning theme, Dickson offered the trail to the community as a refuge for naturalists who live in downtown Asheville.

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CASE STUDY #2:

Isaac Dickson Elementary School, Asheville, North Carolina

Isaac Dickson is a small urban school situated on 17.3 acres of land one-half mile from downtown Asheville, North Carolina. Many of the school's 330 kindergarten through Fifth Grade students live in housing projects and have no exposure to environmental education outside what they get in school. According to principal Vicki Deneen, 50% of the students come from low-income families.

"Academic progress [for our students] is increasingly more challenging," Deneen writes, "because of the poverty issues that consume families living in the projects." As a result, the school uses outdoor service activities to create memorable experiences that engage students as they build new knowledge.

> "Nature is a safe learning environment for students who tend to fail in traditionally structures schools. EE offers unique opportunities for success in students otherwise conditioned for failure."
>
> Carol Basile, Educational Researcher

Environmental education with a service learning focus was implemented so that Dickson could meet the state learning standards. Dickson reflected Asheville City's strategic plan directive, "increase student achievement in Asheville City schools," in its own school improvement plan by creating student learning objectives based on integrating gardening and nature trail activities into all curriculum areas.

Teachers, students, community members, government agencies, and community organizations collaborated to create three specific learning projects for environmental study: the Gardening/Science Club, the Mountain Area Gardens in Community (MAGIC) Program, and the re-establishment of an abandoned nature trail at the rear of the campus.

Academic Outcomes at Dickson

Marked Improvements in Reading, Writing, and Math

"Instead of [taking] the 'easy' way of teaching — students sitting passively, teachers directing a whole class [as they complete] fill-in-the-blank worksheets -", Deneen writes, "the Dickson teachers and administrators modified instruction to include assessment that would identify weak areas and provide ample practice for students to master multiple types of assessments."

The curriculum had the desired effect. During the 1998–99 school year, students at Isaac Dickson Elementary improved their reading, math, and writing skills as measured on state achievement tests. Overall, school achievement was exemplary, with actual growth 9.1 points above expected growth. In addition, in 1999 the school's proficiency in writing rose above the state average for the first time.

Deneen writes, "By providing a sound academic foundation [for] the preparation stage of service learning, [and] a follow-up assessment that mirrors the North Carolina End of Grade and Writing Assessment... service learning and project-based teaching can address North Carolina's Standard Course of Study and [result in] academic growth" (see Tables 5 and 6). Fourth Grade students achieved a remarkable 31 percentage point increase in just one year.

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Summary of Experience with Environment-Based Education at Dickson

Test Scores Document Dramatic Increases in Academic Achievement

The environmentally oriented service projects at Isaac Dickson created opportunities for students to improve their reading, math, and writing skills. Moving instruction out of the classroom into an outdoor learning laboratory created memorable experiences that made learning "stick." Students were interested and engaged in the process. As they built new knowledge, the integration of content, hands-on experiences, reflection, and assessment provided a context that allowed them to meet, and in some cases exceed, state learning standards. ■

TABLE 5. PROFICIENCY* IN READING, MATH, AND WRITING ISAAC DICKSON ELEMENTARY SCHOOL AVERAGES

	Reading	Math	Writing
1998	70%	70%	46%
1999	79%	76%	57%** (state average was 55.3%)

*Percentage of students proficient in skills needed to perform at grade level.
**For the first time, Dickson's proficiency ratings rose above the state average.

TABLE 6. PROFICIENCY* IN READING, MATH, AND WRITING ISAAC DICKSON ELEMENTARY, BY COHORT GROUP

	Reading			Math		
	Gr. 3 Cohort	**Gr. 4 Cohort**	**Gr. 5 Cohort**	**Gr. 3 Cohort**	**Gr. 4 Cohort**	**Gr. 5 Cohort**
1998 (Dickson)	55.0%	53.8%	73.3%	48.0%	46.1%	77.7%
1998 (NC State)	N/A	71.6%	70.9%	N/A	68.2%	79.3%
1999 (Dickson)	75.4%	75.0%	91.7%	68.4%	77.1%	91.7%
1999 (NC State)	73.6%	71.4%	75.8%	70.0%	82.7%	82.4%

*Percentage of students proficient in skills needed to perform at grade level.

Students Study World's Weather

One of Estelle Vollmers' classes at Hawley Elementary School participates in a project based at St. Olaf College in Northfield, Minnesota. Students from all over the world observe and record characteristics of weather (such as measuring snow depth and temperature) and upload their measurements to the college's website. Later, they download a printout that shows weather activity throughout the U.S. and the world.

Vollmers enhances this project by incorporating hands-on inquiry. "For example, the kids have to design a container that keeps hot chocolate hot in the snow belt," she says. "When the environment is integrated into the curriculum, kids get excited [about learning]."

CASE STUDY #3:

Hawley Environmental Elementary School, Milwaukee Public Schools, Milwaukee, Wisconsin

Hawley Environmental Elementary School, a small, two-story brick building that houses 330 students in Grades pre-K through Fifth Grade, was profiled in *Hope for Urban Education: A Study of Nine High-Performing, High-Poverty, Urban Elementary Schools*, a document created by the Charles A. Dana Center at the University of Texas at Austin and published by the U.S. Department of Education in 1999. The school is flanked on three sides by streets and on the fourth by a paved playground. A greenhouse decorates the outside wall of one of the classrooms designated as an Environmental Education Resource Room. In it, flowering plants, bulbs, potting soil, and equipment stand ready to begin growing next spring's garden.

Students at Hawley represent varied ethnicities: African American, Asian American, Hispanic, Caucasian, and "other." 71% of the students come from families who qualify for free or reduced-price lunches. Unlike Condit Elementary (see Case Study #7), which has somewhat similar demographics and has traditionally benefited from strong parental support, Hawley's students are drawn from throughout the city, making parental involvement, let alone support, a challenge. Under Milwaukee's School Choice Program, Milwaukee parents indicate their first, second, and third choice of district schools. Their child's name is entered into a lottery to determine which school s/he will attend. This method of selecting students may influence comparisons of academic achievement of Hawley with other schools.

When Robert Helminiak was appointed principal of Hawley in 1989, discipline problems were rampant, and academic achievement suffered. Even though Hawley had been identified as an environmental school before Helminiak arrived, the curriculum had not consistently focused on the environment. That was one of his first changes.

As reported in *Hope for Urban Education*, Helminiak and the staff wrote a curriculum that contained four major units of study and correlated instructional activities, learning objectives, and educational resources. Later, they integrated that curriculum with Milwaukee's School-to-Work program. The overriding focus was an educational plan that would address student achievement. In the process, the staff became a "professional team" that collaborated on planning and staying current about educational research and testing methods. Innovative thinking was encouraged, and efforts were focused on intensifying the rigor of the curriculum, especially in the mathematical and scientific aspects of environmental education.

Academic Outcomes at Hawley

Students Exceed State and National Averages

According to *Hope for Urban Education*, in 1998 student achievement at Hawley exceeded the state average on state tests and on nationally normed assessments. All of the Third Grade students passed the Wisconsin Reading Comprehension Test in 1998 (see Table 7) compared with only 25% of the Milwaukee Public School population.

Fifth Grade math scores on the Iowa Test of Basic Skills moved steadily upward during the past 10 years, with 89% of students scoring at or above the national average. Fourth and Fifth Grade scores on the state writing assessment approached 100% until the assessment changed in 1995, and now hover near the state average.

In 1997–98, reading scores at Hawley exceeded all other schools in Wisconsin that were located in similar income-level areas—and also exceeded the statewide average (see Table 8).

Summary of Experience with Environment-Based Education at Hawley

Students are More Interested and Achieve at Higher Levels

Hawley's curriculum integrates environmental education into all subject areas. Hawley students are more interested in school and have more opportunities to use information they are learning in practical projects. The focus on achievement and on creating a rigorous environment-based curriculum creates a more disciplined environment as well.

Students' proficiency in reading has steadily improved. They keep pace with or exceed reading and math proficiency scores of other Wisconsin students, demonstrating that environmental issues are an effective medium for improving academic performance across disciplines.

Staff at Hawley stress that the stability of the student population—teachers know their students' older brothers and sisters—contributes to the success of the school. In addition, the collaborative atmosphere among the staff, and the opportunity that environmental education activities afford for more intimate connections between students and teachers, likely play a role in the students' enthusiasm for learning and their resulting academic achievement. ■

TABLE 7. PROFICIENCY ON WISCONSIN READING COMPREHENSION TEST HAWLEY ENVIRONMENTAL SCHOOL* YEAR PERCENT PROFICIENT

Year	Percent Proficient
1994	94%
1995	98%
1996	96%
1997	94%
1998	100%

*Source: Charles A. Dana Center, University of Texas at Austin, *Hope for Urban Education: A Study of Nine High-Performing, High-Poverty, Urban Elementary Schools*. Washington, DC: U.S. Department of Education, Planning and Evaluation Service, 1999.

TABLE 8. STUDENTS AT OR ABOVE PROFICIENCY LEVEL IN READING & MATH COMPARISONS: HAWLEY ENVIRONMENTAL SCHOOL & OTHER WISCONSIN SCHOOLS*

	At or Above Proficient Level in Reading (%)**	At or Above Proficient Level in Mathematics (%)**
Hawley Environmental School	83	48
Wisconsin schools w/75%–100% poverty	38	15
All Wisconsin schools	69	52

*Source: Charles A. Dana Center, University of Texas at Austin, *Hope for Urban Education: A Study of Nine High-Performing, High-Poverty, Urban Elementary Schools*. Washington, DC: US Department of Education, Planning and Evaluation Service, 1999.
**Based on CTB Terra Nova Multiple Assessments and Wisconsin Proficiency Standards.

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Apple Valley's Pond Profile Project

Nets, sketchpads, journals, a copy of *Ishmael*, a pair of old boots for wading in the mud—students carry these as they prepare to "experience" their education on the 12-acre campus of the School for Environmental Studies (SES) at the Minnesota Zoo in Apple Valley.

"It's difficult to have a 'typical' day," says Tom Goodwin, who teaches biology and history to Eleventh- and Twelfth-Grade students. SES is analogous to a comprehensive high school—it offers nearly a full complement of courses with an almost seamless integration of communications, social studies, and environmental science.

Recently, for example, Goodwin's students completed a pond profile project, in which they sampled and tested pond water, analyzed the plants and insects that inhabited its ecosystem, collected scientific and historical data about how the land evolved, researched information about the land's previous human inhabitants, and read essays and journal entries that addressed the spiritual and psychological benefits that specific ecosystems have imparted throughout history. The goal: to explore the broader question "What is the human-water relationship?" and to determine the pond's ecological health so that students could recommend improvements to city officials.

"We were testing for phosphates, nitrates, and dissolved oxygen," says Tom (one of Goodwin's students). "We wanted to determine where fish can live, and how many could live there." Tom and his team canoed and waded, sampling water at various depths and analyzing the plant and insect life they found. He and a friend were at Kinko's until 2:00 a.m. preparing the presentations they were delivering the next day to city officials.

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CASE STUDY #4:

The School of Environmental Studies at the Minnesota Zoo, Apple Valley, Minnesota

Located in Minneapolis' southern suburbs, the School for Environmental Studies (SES) at the Minnesota Zoo is a unique school for 200 juniors and 200 seniors in Independent School District 196.

Students and staff "inhabit" four houses in a studio-style school building that opened in 1995. Each house accommodates 100 students and three instructors and contains a central area for assemblies and large group instruction. This central space, or centrum, is surrounded by 10 cubicle-like offices, called pods, for small-group and independent learning.

Each student has a desk, a bulletin board, and storage space in the pod. The school curriculum is thematic and custom-designed (based on district-wide concepts judged appropriate for the particular grade level) by school staff.

The staff organized the curriculum around environmental education and broke the daily schedule into four 88-minute blocks. The day begins with a 10-minute overview of the day's agenda in the centrum, and then the students disperse to their individual or group-or team-based activities.

As the founding school of the Worldwide Learning Network, SES connects with teachers and students from Sweden, Chile, Ecuador, and Niger, as well as with District 196 students. Learning is inquiry-based and has real-world applications, whether it involves designing a Web page for Jane Goodall's Roots and Shoots program, teaching local Fourth Graders about ecosystems, or building a dock and trail around Birch Pond.

"Teachers facilitate more than they teach," instructor Goodwin says. He explains that students learn skills in a coherent context that is hands-on and experiential, and the flexible scheduling allows them to pursue activities as the project, and not the clock, dictates. Assessment includes evaluation rubrics, long-term portfolios, evaluative journals, and the normal standardized tests, such as the ACT, common to high school students across the nation.

Academic Outcomes at SES

Students Exceed State and National Norms in All Academic Areas

Test data collected over the last two years shows that SES students have exceeded state and national norms, as measured by ACT raw scores, in all academic areas (see Table 9). SES student composite scores also surpassed those of Independent District 196, where SES is located.

Although SES is a specialized school, each incoming class reflects district demographics, including academic performance and number of students requiring special services.

Summary of Experience with Environment-Based Education at SES

Students are Motivated and Self-Directed Learners

Based on interviews with students and teachers at SES, environment-based education motivates students to self-direct their learning and to want to learn more. Incorporating real-world projects such as the

"Teachers trained in EE, in asking higher-level questions, and in cueing students to look for connections, can help students deepen their learning in all subject areas."

Carol Basile, Educational Researcher

pond study makes learning relevant and sharpens students' skills in communication, data analysis, and working as part of a team. The projects provide a connection to the local community, and are seen by students and local leaders as useful and practical.

The academic scores on the ACT test show that SES students perform better than traditionally educated students and that SES' environment-based curriculum increases competence in English, mathematics, and science. ■

TABLE 9. COMPARISON OF ACT BY RAW SCORE SCHOOL OF ENVIRONMENTAL STUDIES (SES)

Year	Students Taking Test (%)	Sample	English	Math	Reading	Science	Composite
1996–97	60%	SES	22.6	22.1	24.7	24.1	*23.3
		Minnesota	21.2	21.8	22.5	22.5	22.1
		National	20.3	20.6	21.3	21.1	21.0
1997–98	65%	SES	22.5	22.5	24.6	24.2	**23.6
		Minnesota	21.2	22.2	22.3	22.5	22.2
		National	20.4	20.8	21.4	21.1	21.0

*District composite score was 22.5
**District composite score was 22.8

Who is "Gifted & Talented" and Who is "Special"?

In the course of her work as Executive Director of the Kentucky Environmental Education Council in Frankfort, Kentucky, Jane Eller frequently visits schools throughout her state. This is her favorite story:

"I traveled to Southwestern High School in Somerset, which, in addition to having a greenhouse and a nature trail, has a state contract for rehabilitating raptors. Teachers work with students as they learn to care for those birds, and in the process the students learn not only biology but also about ecosystems and other environmental education concepts.

"When I was visiting, the students took me on a tour of the school and the program. They explained the science concepts underlying what they were showing me, and they were excited about what they knew. They were so articulate! I had been told that some of the students in the group were from the gifted and talented class, and others from special education classes. But I couldn't tell which was which."

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CASE STUDY #5 :

Kentucky Public Schools

Schools in Kentucky are completely site-based and site-controlled. A council decides what will be taught, and how funds will be spent. The State Department of Education rewards schools that do well on tests with additional funding, and sanctions those who don't by sending in distinguished educators to do in-service training. Schools that don't perform well may also be closed down.

The tests ask open-ended questions. For example, a Fourth Grade student may be asked this question: *You are walking up a mountain when you notice that the plants change from one kind to another as you go higher. List at least two specific changes you might see. And describe the factors that cause these changes.*

To do well, students must know more than facts. They must also be able to write well, think critically, and integrate knowledge. "Teachers who realize this use theme-based teaching," Eller says, "and many use the environment as a way to do that." Eller notes that schools that have taken this approach have improved their test scores. "Because teachers realize the environment can be used as a theme to integrate knowledge, and that integration is essential to doing well on the test, more schools are now doing environment-based curricula. In fact, we estimate that about 80% of our schools have outdoor classrooms now."

Renaissance Across the State

Eller says that there has been a renaissance in environmental education in Kentucky. She names several schools that have developed outstanding programs: Southwestern High School in Somerset; Georgetown Middle School; Tompkinsville Elementary School, Tompkinsville; Wheatley Elementary and Valley High in Louisville; Jackson County Middle in McKee; and Clay County High School in Manchester. The last three schools are cited in the Lieberman-Hoody report, *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning.*

Eller says her agency is a resource for teachers who want to reap the benefits of environment-based education and learn how to use it to maximum advantage. When states realize that kids actually like learning about the environment, and when it actually helps students excel in those areas important to school reform, the educational community has to take a second look. "We need to help them begin to see us as people who are just as interested in improving education as we are in improving the environment. We should be educators first," says Ellers.

Tompkinsville Elementary School, Tompkinsville, Kentucky

Around 1995, Tompkinsville got an outdoor classroom. A group of teachers and community members built trails, observation decks, and an outdoor amphitheatre; created garden beds; and planted flowers on the 27-acre rural campus. A Kentucky "pride grant" recently provided the money to build a shelter near the orchard that was created with the cooperation of Wal-Mart and the local FSA in 1999.

"Teachers are trying to collaborate across grade lines," principal Cecilia Stevens says. "In fact, high school students came to work with and teach our students in the orchards."

Tompkinsville's 630 students live in a rural area. Many of their families qualify for the free lunch program. The school serves grades pre-K through Fifth Grade. Prior to 1995, test scores in science, reading, and social studies were low.

Stevens' predecessor laid the groundwork for an environmental studies curriculum that Stevens is now implementing. Key features include a focus on science, the integration of science concepts across the curriculum, and an emphasis on using the local environment as a context for learning.

"Our survival depends on the land. Our students might explore how logging affects the economy, look at the pros and cons, and visit local lumber mills."

— Cecelia Stevens, Tompkinsville Principal

Stevens says sometimes parents will come in to teach about trees, for example. Students will study the types of trees and how they are important to the county, learn the history of trees in their area, learn how to calculate board feet from different tree species, and research information through the Internet.

In another project, students roped off a six-foot by five-foot plot of land, observed changes, and collected soil and insect samples. They shared their discoveries by e-mailing another school that was working on a similar activity, corresponding with students of similar age but who lived on different geography.

Academic Outcomes at Tompkinsville

Steady Improvement in Achievement

Tompkinsville's test scores have steadily improved since 1995 (see Table 10), and Kentucky is proud of the academic progress this school and others have achieved. Over four years, science scores increased by 25 percentage points, reading by over 21 percentage points, and social studies by nearly 40.

Summary of Experience with Environment-Based Education at Tompkinsville

Environment-Based Curriculum Makes Learning Relevant and Accessible to All

Since incorporating environmental issues into the curriculum, Tompkinsville Elementary (and other Kentucky schools) have increased their achievement in science, reading, and social studies on statewide tests. The curriculum's focus on site-based, real-world projects makes learning relevant and accessible to all students, whether they are academically gifted or academically challenged.

Test results at Tompkinsville and other Kentucky schools support the assertion that environment-based education is a factor that positively impacts student achievement. ■

TABLE 10. FOURTH-GRADE SCORES ON THE KENTUCKY INSTRUCTIONAL RESULTS INFORMATION SYSTEM (KIRIS)* TOMPKINSVILLE ELEMENTARY SCHOOL

Year	Science	Reading	Social Studies
1995–96	24.15	49.54	30.37
1996–97	35.82	61.87	60.19
1997–98	41.14	58.85	64.20
1998–99	50.00	72.00	70.00

*Total possible score: 100

"Nobody's Ever Asked Me to Study Something Like This Before!"

Daniel was bright, but never participated in anything. He never turned in his work, and his consistent response to any assignment was, "Why do we have to do that?"

One day his teacher began a thematic unit on cycles. She decided to start with the cycle that was least familiar—minerals—and brought in a bare-bones terrarium that held only soil and earthworms. Students would add various materials to the terrarium and observe the changes that occurred.

Daniel was right there—doing assignments, raising his hand to answer questions, working with his classmates. And every morning, before school started, even before the teacher arrived at the classroom door, Daniel was there waiting for her.

He wanted to check on the terrarium and see what was happening, he told his teacher. When she asked why he was so excited about the terrarium, but never got that excited about other work, Daniel said, "Nobody's ever asked me to study something like this before!"

CASE STUDY #6:

Pine Jog Environmental Education Center, West Palm Beach, Florida

Teachers used to view Pine Jog Education Center as a day-long field trip, explains Director of Education Susan Toth. "We knew we weren't satisfied to be stand-alone field trips without a real connection to the classroom," she says. So the Center re-thought its mission.

In 1994–95, partnering with the Palm Beach County School District and funded by the John D. and Catherine T. MacArthur Foundation, Pine Jog identified five schools whose development as model schools in environmental education and accountability they wanted to facilitate: Del Prado Elementary, Greenacres Elementary, Melaleuca Elementary, Northmore Elementary, and Westward Elementary.

"It's corny, I know, but nature is a natural. Kids are learning and liking it".
—Model School Teacher

Pine Jog defines a model school in environmental education as one working in partnership with Pine Jog and characterized by the presence of the following components:

- Commitment by the principal and teachers to incorporate an environmental education focus into school activities and curriculum, allocate funds to support the model school program, and allocate time for teachers to plan.
- Field experiences for students in natural settings.
- Professional development for teachers in environmental content and/or teaching strategies.
- Teacher development of multi-disciplinary instructional units, using the environment as a unifying theme.

Eleven schools are currently identified as model schools in environmental education. Ten elementary schools focus on Grades K–5 and one middle school focuses on Sixth Grade. Schools are distributed throughout the county and include the western agricultural communities, schools with high populations of children designated as "at risk" and with overall low test scores, and a life science magnet school. The model schools are geographically as well as demographically diverse.

During the 1997–98 academic year, Pine Jog served 189 classes, approximately 7,000 students, and 189 teachers through the model school program.

All schools received start-up funds through Pine Jog from grants from the John D. and Catherine T. MacArthur Foundation and contracts with the Palm Beach County School District. All schools have made a commitment to become financially self-sustaining and are in various stages of implementing plans to achieve the goal.

Success of the model school program centers on the empowerment of teachers because they develop the curriculum they teach. Teachers must exhibit enthusiasm for teaching environmental topics using inter-disciplinary teaching units, show interest in exploring and applying new subject matter and catalyze student motivation to learn, consequently improving student performance.

The model school program is environmentally thematic, focusing on the "real world" and building on children's innate interest in nature. Students see their school experiences as significant and relevant; they

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make connections and see interrelationships. Learning begins in the classroom and extends to the schoolyard, the home, and the Florida natural outdoors.

Educational outcomes (based on 39 responses to a Pine Jog survey of model schools in February of 1997) reported by teachers and school administrators correspond to case study research reported in *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning.*

Results observed in the Pine Jog Model Schools in Environmental Education program include

- increased student enthusiasm for learning,
- improved student learning of subject matter,
- improved student grades,
- more engaged and enthusiastic teachers,
- content that crosses traditional disciplinary boundaries,
- collaborative instructional planning,
- use of more innovative instructional strategies into the classroom,
- curriculum developed around integrating themes, and
- teachers becoming change agents in their schools.

Connie Gregory, former principal at Melaleuca Elementary and current Director of School Improvement for the Palm Beach City School District, writes,

> *"An important element of making education work is making it interesting and relevant to our students. Becoming an Environmental Education Model School has helped us bring the real world into the classroom. We found our students tested better, making significant improvement in their writing and language arts skills because they were choosing to write about what interested them, which was the environment. In writing about the environment, their writing had meaning. Likewise, our teachers are turned on by the new instructional strategies they are using and the improvements they are seeing in their students. And we all know a turned-on teacher is a better teacher."*

Academic Outcomes at Pine Jog Model Schools

Higher Academic Achievement at All Model Schools

Reports from teachers, administrators, parents, and students indicate that using the environment as an integrating context for learning has improved students' academic achievement as measured on two Florida assessment tests, Florida Writes and the Florida Comprehensive Assessment Tests (FCAT).

At **Del Prado Elementary School**, over the four-year period students made significant gains on the Florida Writes assessment. 16% of the students scored at the highest level in the Math Assessment in 1999 as compared to 9% in 1998.

At **Greenacres Elementary**, where 67% of the students receive free or reduced-price lunches, student achievement improved in narrative and expository portions of Florida Writes. In just one year, between 1998 and 1999, students gained 16 percentage points in mathematics.

Melaleuca Elementary students' writing scores rose from 1.9 on narrative in 1995 to 2.9 in 1999. Math scores also moved upward between 1998 and 1999, scoring at or above level 5 (the highest score).

Northmore students' scores improved in narrative and exposition on Florida Writes, although between 1998 and 1999, there was no change in the reading score on the FCAT. In math, however, 22% scored at or above level 5 in math in 1999 as opposed to 10% only a year earlier. 87% of Northmore students receive free or reduced-price lunches, and the student population is 94% African-American.

At **Westward Elementary**, also a high minority school where 84% of the students receive free or reduced-price lunches, students achieved a 3.1 on the narrative portion of Florida Writes (a perfect score is 4.0). Four years earlier, that score was 1.8. Math achievement significantly improved between 1998 and 1999, increasing from 17% to 28%.

See Table 11 for additional details about achievement on Florida Writes and the FCAT for each of the five Florida schools.

Summary of Experience with Environment-Based Education at Pine Jog Schools

Five -Year Record of Success

Test scores of students in Florida's Model Schools in Environmental Education support the assertion that environment-based education improves students' skills in writing, reading, and math. Information collected from teachers and administrators involved in model school projects confirms that students who are in an environment-based program are more enthusiastic about learning, learn more deeply, and improve their grades. Collaborative planning and the interdisciplinary focus of an environmental program, such as the one at Pine Jog, leads teachers to be more innovative and become the change agents that help their students succeed and their school achieve overall reform goals.

The model school program has a five-year record of success. Within the first two years, schools involved in the model program moved from receiving 100% outside financial support to receiving only 50% outside support, raising the rest of the money for the program themselves. The ability of schools to pay varies significantly. Some schools are extremely affluent and it is easy for them to pay almost 100% of their costs while other schools, such as critical needs schools, struggle to find even minimal funds.

The fact that schools are moving towards self-sufficiency and have a three-year track record of involvement makes a strong statement about the commitment of the principals and teachers to the Model Schools in Environmental Education program—a positive approach to improving educational outcomes for students while at the same time increasing environmental awareness. ■

TABLE 11. ACHIEVEMENT SCORES, FOURTH GRADE: FLORIDA WRITES AND FLORIDA COMPREHENSIVE ASSESSMENT TEST MODEL SCHOOLS IN ENVIRONMENTAL EDUCATION AND ACCOUNTABILITY

School	Demographics	Florida Writes			FCAT		
		Year	Narrative	Expository	Year	Reading	Math
Del Prado	8% black 73% white 9% Hispanic	1995	3.2	2.4	1998	80%	9%
		1999	3.8	3.1	1999	81%	16%
Greenacres	10% black 52% white 33% Hispanic 5% other	1995	2	1.5	1998	38%	26%
		1999	2.6	2.7	1999	44%	44%
Melaleuca	25% black 48% white 25% Hispanic 2% other	1995	1.9	1.5	1998	35%	20%
		1999	2.9	2.6	1999	42%	36%
Northmore	94% black 2% white 2% Hispanic 2% other	1999	2.9	2.6	1999	42%	36%
		1999	2.7	2.3	1999	No change	22%
Westward	79% black 10% white 7% Hispanic 4% other	1995	1.8	1.7	1998	34%	17%
		1999	3.1	2.8	1999	36%	28%

Note: How well students score on the test is a function of the quality of their responses, rather than a function of "grading on a curve." The Florida Writes test directs students to respond to two prompts: one narrative, and one expository. Scoring is performance-based, and the highest possible score on Florida Writes is "4." FCAT measures reading and math proficiency; "level 5" represents the highest possible score on the FCAT.

Florida schools receive annual "grades" on their performance from the Florida Department of Education. Minimum competency is defined as level 2 or above in reading and math, and level 3 or above on Florida Writes. Further, 60% of the elementary school must score a 2 or above on FCAT reading and a 2 or above on FCAT math. Fifty percent of the school must score a 3 or above on Florida Writes. These scores, plus other specified criteria, earn a school the grade of "C." To achieve a grade of A or B involves more stringent requirements.

CASE STUDY #7:

Condit Elementary School, Bellaire, Texas

Leaders at Condit Elementary School, Houston Independent School District, decided to cooperate with Carol Basile, co-author of a program designed to enhance transfer — the ability to take knowledge from one context and apply it to another — in young children. The program was an environmental education program called *Nature at Your Doorstep*. Carol collaborated with Martha Fields to teach the program to Field's class of Third Graders.

Condit Elementary's student body is made up of kids from "both sides of the tracks": those who live in apartments, and those who live in upper-middle-class, single-family homes. Ethnicities vary, from Hispanic to African-American to Caucasian to Asian. The school is considered a "high-achieving" urban school with strong parental and administrative support.

"A Houston Medical Center study showed that children under stress respond to art, music, and nature. When you watch a squirrel, there are no wrong answers about where his habitat is. You don't' have to measure up to Johnny or Suzie or Billie."

Carol Basile, Educational Researcher

Basile's study involved splitting a group of 45 Third Grade students into two classes, one to be taught in a traditional mode and the other in an experimental mode. She worked with the students in these classes over a seven-week period. Basile's goal was to determine (1) if and what kind of transfer occurred; and (2) how knowledge transferred when Third Grade children were given problem situations.

The traditional group experienced classroom-based instruction (with the exception of one weekly nature walk and one field trip to a local nature center) to learn about habitat. The children read and discussed forest, prairie, wetland, and urban habitats. They learned about habitats through art projects, worksheets, and environmental activities that could be done in the classroom. None of the activities required any kind of systematic investigative process.

"These achievements are among the 'interesting and unpredictable things' that can happen as a result of environmental education. Kids [begin to] respect living things and each other."

Carol Basile, Educational Researcher

The experimental group used *Nature at Your Doorstep*, a skill-based curriculum based in the scientific method. In each investigation, students "become scientists" by reading about and researching topics such as habitat, biodiversity, trees, or food webs. They develop their own questions and collect their own data. They learn to analyze data by charting and graphing. Every week the students explored a new problem. For example, they might try to find out whether trees can be habitats for some animals. Students worked outdoors three out of five days, and took one field trip to the local nature center.

Academic Outcomes at Condit

Significant Improvement in Students' Abilities at Knowledge Transfer

Basile used the following instruments to measure and analyze results:

- Knowledge Indicator Instrument,
- Matrix Analogies Test,
- Science Attitude Survey, and
- Science Observation Instrument.

She found that though both groups were able to transfer knowledge in similar situations (an example of near transfer), only the experimental group succeeded at far transfer (the ability to transfer knowledge to a vastly different context) in a statistically ($p = .001$) and educationally significant ($D = 2.19$) way.

Basile reported that when students were asked the question, "Do you think you might ever find a baby bird in your schoolyard?", some children simply said that there weren't any birds in their schoolyard, so it couldn't happen. After the treatment program, the same students told stories about not only birds, but also about squirrels that had fallen from their nest or frogs that they had seen injured on the playground. The program was able to give them knowledge about animals, a process of investigation, and a meaningful context in which to see a variety of natural interactions.

Basile suggests that teaching for and measuring transfer is at least as important as measuring achievement, because transfer enhances academic performance and fosters higher-level thinking skills and problem solving. Teaching for transfer involves exposing students to a combination of knowledge, process, and hands-on experience to help them make connections across different fields and deepen their learning.

Basile notes that transfer is most successfully mastered when students are given proper cues to enhance and strengthen the transfer process. What's needed: helping students to make connections they might otherwise miss; using higher-level questioning strategies including those needed for analysis, synthesis, problem solving, and evaluation; and facilitating the *habit* of making connections.

And they learn. "Toward the end of the year," Basile says, "the kids sent me cards. The notes they wrote included amazing levels of facts and knowledge about animals. I was struck that something taught in such a short period of time stuck with them so long."

Summary of Experience with Environment-Based Education at Condit Elementary

EE Provides Tools for Teaching Transfer of Knowledge

The discipline of environmental education, as outlined in NAAEE's *Environmental Education: Guidelines for Excellence*, already provides all of the knowledge components that can lead to transfer, Basile says. Because environmental education is interdisciplinary and focuses on both content and process, it is an appealing way of helping students master academic skills and make connections that lead to higher-level thinking.

When students "become scientists" rather than learn "about science," their skills in questioning, investigation, data interpretation, analysis, and problem solving grow. Exploring their environment capitalizes on students' intrinsic interest in the world around them. Using problem-solving as a teaching strategy enhances students' ability to apply knowledge from one area to another. ■

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APPENDIX

RESEARCH ON ENVIRONMENTAL EDUCATION

To date, most of the research on the connection between environmental education and academic achievement has been qualitative and/or anecdotal. Individuals in various U.S. schools have tried to quantify its effect on other school subject areas, but reports are scarce. In addition, many of the existing studies are not "scientific" in the sense that they may or may not have used control groups, and there may have been more than one variable influencing the outcome. Distinctions must be made among which types of programs, which types of materials and resources, and which types of student experiences are used, and which outcomes each produces.

The case studies presented in this report support the conclusions reported in *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning*, that students can improve in reading, math, science, social studies, and writing as a result of a curriculum that is environment-based. The evidence so far suggests that more stringent research would be beneficial. Not only would it give teachers another venue for engaging students (over and over again teachers and administrators report that children like environmental education, and engaged students are more enthusiastic about learning) but such research could provide additional information about which environment-based programs and strategies are most effective for achieving national school reform goals. Such research should examine larger sample populations, control for independent variables, and present a complete data analysis.

Qualitative studies on the effectiveness of environment-based education are plentiful. More *quantitative* studies are needed, however, to convince doubtful teachers of the value of environmental-based learning.

HISTORICAL PERSPECTIVE ON ENVIRONMENTAL EDUCATION RESEARCH

Since the early 1970s, the volume of published and unpublished research in environmental education has grown at an increasing rate. Early reviews included a limited number of studies in the field (e.g., Roth and Helgeson, 1972: 94 studies from 1950–1969; Roth, 1976: 100 studies from 1973–1976).

The launch of the *Journal of Environmental Education* (1969), and its shift to a research-reporting journal format (1979), seemed to increase the number of studies conducted. The North American Association of Environmental Education (NAAEE) has documented the following: Iozzi, 1981: 263 journal reports and 88 dissertations from 1970–1981; Marcinkowski and Mrazek, 1996: 311 additional dissertations from 1971–1980, and 213 journal reports and 305 dissertations from 1981–1990.

By 1990 there were about 500 journal reports and 700 dissertations in or closely related to environmental education. Time, effort, and cost have prevented preparing a collection of research on environmental education for any portion of the period 1991–2000.

SURVEYING THE RESEARCH:

Though these ERIC and NAAEE documents don't contain evaluations on environmental education research, they do give some idea of:

- which texts and materials were being used;
- what we know about how environmental education was being infused into the curriculum (mostly through science and social studies);

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- how environmental education is achieving or not achieving the goals of the 1978 UNESCO Conference in Tbilisi (i.e., awareness, literacy, and action); and
- whether environmental programs impacted academic achievement (Most studies did not address this issue. When they did, they looked primarily at science outcomes.).

Reviews and syntheses on environmental education research have become more difficult to prepare as the body of research has grown over time. The research itself has become more diverse with respect to method and substance. Most reviews (Roth and Helgeson, 1972; Roth, 1976; Iozzi, 1984; and Volk and McBeth, 1997) have been qualitative rather than quantitative. Only one analysis of the various studies on environmental education research has been published to date (Hines, 1984; Hines et al., 1988). There has been no formal attempt to synthesize the entire body of research in the field since Iozzi (1984).

WHAT PAST RESEARCH REVEALS

NAAEE made the first attempt to synthesize and publish what was learned through this large body of research in the early- to mid-'80s (Iozzi, 1984). In that volume Tom Marcinkowski at the Florida Institute of Technology compiled information on ecological foundations and the sciences; and Hines (1984; Hines et al., 1988) looked at responsible environmental behaviors that resulted from education in environmental issues.

Volk and McBeth's *Environmental Literacy in the United States* (1998), a qualitative review of studies that investigated one or more components of environmental literacy, summarized the key thinking in the field and suggested that community investigations, citizenship participation, and environmental studies courses are the most effective methods for achieving the desired state of environmental literacy in the U.S.

In summary, there is a growing disparity between the number of individual studies reported in the field, and efforts to collect and synthesize that data. There is also a growing disparity between the availability of comprehensive collections and syntheses, which could address accountability and decision-making needs within the field.

RECENT PUBLICATIONS

Gerald Lieberman and Linda Hoody (1998), in *Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning*, suggest that when educators develop their instructional practices in the context of the local environment, students do better academically. Their qualitative study of 40 schools provides the results of surveys, interviews, observations, and in some cases, quantitative comparisons of achievement tests, demonstrate how, why, and to what degree using the environment as a context enhances learning. For example, children benefit by becoming "part of something bigger than they are." In addition,

- their grades improve,
- their understanding of the world becomes more comprehensive,
- they sharpen their thinking and problem-solving skills,
- they become aware and appreciate diverse viewpoints as an aspect of democratic society and
- they create fewer discipline problems.

Based on a survey of existing literature culled from dissertation databases, educational clearinghouses, and professional education organizations, NAAEE, in *Research Report on the Benefits of Environmental Education*

for Youth (in press), reports that the strategies commonly used in environmental education—inquiry and problem-based learning (PBL), democratic learning practices that also emphasize varied learning styles, and issues-based content—contribute positively to academic achievement in all academic areas, not just in knowledge of environmental concepts.

ONGOING AND FUTURE INITIATIVES

The research initiatives that we know about — those in progress, and those pending approval — are listed below.

- SEER has recently completed a quantitative follow-up to the *Closing the Gap* report that used paired comparisons of school programs. Though publication information is not yet available, preliminary findings support the assertion that using the environment as a context for learning can increase academic achievement.
- Nels Troelstrup, in the Department of Biology and Microbiology at South Dakota State University, is writing the results of a three-year study to assess the effect of environmental awareness activities on student performance in 34 middle and high schools (3,000 students). Preliminary results show that environmental education did positively affect student performance, irrespective of school size or setting (rural vs. urban).
- SEER, working with the Minnesota Department of Children, Families, and Learning (DCFL), is supporting the development of a network of 15 model EIC schools. DCFL has formally built this EIC modeling plan into the state education workplan.
- Graduate student Danielle Dennis is conducting a study to assess whether or not environmental education is increasing science achievement levels in special needs students. Her work will be conducted at an environmental theme school in Duluth, Minnesota.
- Tom Marcinkowski and Gordon Shupe proposed to the EPA, in 1999, the development and piloting of an electronic survey to gather information on the nature and performance of multi-grade environmental programs in public schools. The goal: to collect information and test scores that will determine the extent of coverage in schools of environment issues, and to assess the effects of the incorporation of these issues on teaching and learning.

LIMITATIONS OF CURRENT STUDIES

The case studies we know about seem to offer strong support for the positive role that environment-based learning can play in academic achievement. However, these studies do have their limitations:

- The data assume that test scores are an acceptable indicator of student achievement and the use of test scores as the primary academic achievement indicator is coming under question. (However, at this point, test scores are the most universal and quantifiable tool we have to measure learning.)
- Measures of achievement are almost all becoming specific to individual states as state-specific academic standards have been formalized in 49 of the 50 states, rather than nationally normed, making it difficult to make comparisons.
- There are few, if any, controls for independent variables such as the effects of teaching methods, training and ability of the different educators involved, etc.

To make meaningful conclusions about the effects of environment-based learning on student achievement, we need many more studies, and quantitative ones that include analyses of the student and program characteristics associated with different types of learning outcomes. ■

The National Education & Training Foundation, chartered by Congress in 1990, is intended to fulfill a unique role in the environmental education and training field. The Foundation fosters environmental learning at the national level and provides a voice for learning-oriented solutions to environmental problems and a forum for unique, unusual and effective working relationships that focus on the environment. These include partnerships between government, business, citizen groups and individuals. As part of its Congressional charter, the Foundation also works with the U.S. Environmental Protection Agency to support scientifically sound and effective development of non-regulatory voluntary programs for environmental stewardship.

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